

B3 19. (Once Amended) A polishing head in an apparatus for chemically-mechanically polishing semiconductor wafers, the polishing head comprising:

- (a) a first side having at least a portion thereof operably connectable with a spindle on the apparatus; and
- (b) a second side opposite the first side, the second side having a flat rim surrounding a substantially spherical cap shape that is concave relative to a semiconductor wafer, the spherical cap shape comprising an outer region that, in conjunction with the flat rim, is adapted to apply a first force onto a semiconductor wafer against a polishing pad, and an inner region adapted to apply a second force onto the semiconductor wafer against the polishing pad, the first force being greater than the second force, and wherein the first force and the second force cause the polishing pad to planarize the semiconductor wafer substantially uniformly.

Please add the following new claim:

B4 20. (New) A polishing head for chemically-mechanically polishing semiconductor wafers, the polishing head comprising:

- (a) a first side having at least a portion thereof operably connectable with a spindle on the apparatus; and
- (b) a second side opposite the first side, the second side having a substantially spherical cap having a concave shape relative to the semiconductor wafer to be polished comprising an outer region adapted to apply a first force and an inner region adapted to apply a second force.

REMARKS

1. Office Action Summary

Prior to entry of this amendment, claims 1-19 are pending. Claims 1, 9 and 19 are independent claims. In the Office Action dated August 14, 2002, the Examiner rejected claims 1-10 and 15-19 under 35 U.S.C. § 102(b) as being anticipated by Pasch et. al (U.S. 5,769,692). Claims 11-14 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Pasch et al.

2. Claim Rejection – 35 U.S.C. § 102

The Examiner has rejected claims 1-10 and 15-19 under 35 U.S.C. § 102(b) as being anticipated by Pasch et. al. Applicant respectfully traverses this rejection. Pasch et al. discloses a substrate holder assembly for immobilizing a substrate during polishing. Prior to polishing, the substrate is polished by conforming the substrate to a convex spheroid, oblate-spheroid, or hyperboloid-shaped carrier film (col. 6, lines 26-42). When the substrate contacts the polishing pad during polishing, the shape of the carrier film causes a die area (an inner portion) of the substrate to be subject to a greater force than a guardband area (an outer portion) of the substrate (col. 7, lines 32-39).

Claim 1

Applicant has amended claim 1 so that the first force applied to the wafer is greater than the second force applied to the wafer. As noted above, because of the spheroid, oblate-spheroid, or hyperboloid shape of the carrier film disclosed in Pasch et al., the force applied to the outer, or guardband area of the substrate is less than the force applied to the inner, or die area of the substrate. Thus, the forces applied to the carrier film in Pasch et al. result in the guardband area undergoing less polishing than the die area (col. 7, lines 32-36). In claim 1, unlike in Pasch et al., the force applied at the perimeter, or outer area, of the wafer is greater than the force applied at the center region of the wafer, thus resulting in a uniformly polished wafer. Because the relative forces applied to the substrate in Pasch are different than the relative forces applied to the wafer in claim 1, Applicant respectfully submits that this rejection has been overcome. Withdrawal of this rejection is therefore respectfully requested.

Claims 2-8 depend from claim 1. Applicants respectfully assert that dependent claims 2-8 are allowable for at least the same reasons as provided for claim 1. Reconsideration is respectfully requested.

Claim 9

Applicant has amended claim 9 so that the first force applied to the perimeter region of the wafer during polishing is greater than the second force that is applied to the center region of the wafer. As noted with respect to claim 1, in Pasch et al. the spheroid, oblate-spheroid, or hyperboloid shape of the carrier film causes the force applied to the outer, or guardband area of the substrate to be less than the force applied to the inner, or die area of the substrate, thus

resulting in the guardband area undergoing less polishing than the die area. In claim 9, unlike in Pasch et al., the force applied at the perimeter of the wafer is greater than the force applied at the center region of the wafer, thus resulting in a uniformly polished wafer. Because the relative forces applied to the substrate in Pasch are different than the relative forces applied to the wafer of claim 9, Applicant respectfully submits that this rejection has been overcome. Withdrawal of this rejection is therefore respectfully requested.

Claims 10 and 15-18 depend from claim 9. Applicants respectfully assert that dependent claims 10 and 15-18 are allowable for at least the same reasons as provided for claim 9. Reconsideration is respectfully requested.

Claim 19

As with claim 1, Applicant has amended claim 19 so that the first force applied to the wafer is greater than the second force applied to the wafer. In Pasch et al., the force applied to the outer, or guardband area of the substrate is less than the force applied to the inner, or die area of the substrate. Thus, the forces applied to the carrier film in Pasch et al. result in the guardband area undergoing less polishing than the die area (col. 7, lines 32-36). In claim 19, unlike in Pasch et al., the force applied at the perimeter of the wafer is greater than the force applied at the center region of the wafer, thus resulting in a uniformly polished wafer. Because the relative forces applied in Pasch are different than the relative forces of claim 19, Applicant respectfully submits that this rejection has been overcome. Withdrawal of this rejection is therefore respectfully requested.

New Claim 20

Applicant has added new claim 20 by essentially writing claim 2 in independent form to have the spherical cap be concave in shape relative to the semiconductor wafer. Applicant notes that Pasch et al. discloses and compares spheroid, oblate-spheroid, and hyperboloid shapes that are convex relative to the substrate (Figs. 14 and 16) and does not disclose a carrier film that is concave in shape. Moreover, Applicant respectfully asserts that there is no suggestion to modify the carrier film in Pasch et al. to have a concave shape. Pasch et al. clearly discloses that due to the geometry of the carrier film, the resultant force applied to the die area of the substrate is greater than the force applied to the guardband area of the substrate during polishing (col. 7, lines

32-39). Those skilled in the art would readily understand that if the carrier film in Pasch et al. were modified to be concave relative to the substrate, the die area would no longer be the first area to contact the polishing pad during polishing, and thus the force applied to the die area would no longer be greater than the force applied to the guardband area. Allowance of claim 20 is therefore respectfully requested.

2. Claim Rejection – 35 U.S.C. § 103

The Examiner has rejected Claims 11-14 under 35 U.S.C. § 103(a) as being unpatentable over Pasch et al. Applicant respectfully traverses this rejection. A brief summary of Pasch et al. has been provided above.

Claims 11-14

Claims 11-14 depend from claim 9 and thus their allowability follows from claim 9. As noted above, claim 9 has been amended so that the first force applied to the perimeter region of the wafer during polishing is greater than the second force that is applied to the center region of the wafer. In Pasch et al., the force applied to the outer, or guardband area of the substrate is less than the force applied to the inner, or die area of the substrate. Therefore, Applicants respectfully assert that dependent claims 11-14 are allowable for at least the same reasons as provided for claim 9.

CONCLUSION

In conclusion, Applicant has amended claims 1, 9 and 19 and has added new claim 20. Applicants respectfully submit that all pending claims are allowable in their present form, and hereby requests allowance of claims 1-20. If any questions arise or issues remain, the Examiner is invited to contact the undersigned at the number listed below in order to expedite disposition of this application.

Pursuant to 37 C.F.R. 1.121, a copy of the amended claims in marked up form is included in the attached appendix.

Respectfully submitted,

A handwritten signature in cursive script, appearing to read "Anastasia Heffner", written over a horizontal line.

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APPENDIX

1. (Once Amended) A polishing head in an apparatus for chemically-mechanically polishing semiconductor wafers, the polishing head comprising:
 - (a) a first side having at least a portion thereof operably connectable with a spindle on the apparatus; and
 - (b) a second side opposite the first side, the second side having a substantially spherical cap shape comprising an outer region adapted to apply a first force onto a semiconductor wafer against a polishing pad, and an inner region adapted to apply a second force onto the semiconductor wafer against the polishing pad, the first force being greater than the second force [being different from the first force], [whereby] and wherein the first force and the second force cause the polishing pad to planarize the semiconductor wafer substantially uniformly.

9. (Once Amended) A method of polishing a semiconductor wafer in a chemical mechanical polishing apparatus, the method comprising:
 - (a) providing a chemical mechanical polishing apparatus having a polishing head comprising a first side having at least a portion thereof in contact with a spindle on the apparatus, and a second side opposite the first side, the second side having a substantially spherical cap shape comprising an outer region and an inner region;
 - (b) securing the semiconductor wafer in the polishing head, the semiconductor wafer having a center region and a perimeter region;
 - (c) inserting a polishing pad in the apparatus; [and]
 - (d) applying a first force using the outer region of the spherical cap shape, the first force tending to press a perimeter region of the semiconductor wafer against a polishing pad;
 - (e) applying a second force using the inner region of the spherical cap shape, the second force [being different from the first force and] tending to press a center region of the semiconductor wafer against the polishing pad, the first force being greater than the second force; and

(f) polishing the semiconductor wafer such that the first force and the second force cause the polishing pad to remove semiconductor surface at substantially the same rate in the center region and in the perimeter region of the semiconductor wafer.

19. (Once Amended) A polishing head in an apparatus for chemically-mechanically polishing semiconductor wafers, the polishing head comprising:

(a) a first side having at least a portion thereof operably connectable with a spindle on the apparatus; and

(b) a second side opposite the first side, the second side having a flat rim surrounding a substantially spherical cap shape that is concave relative to a semiconductor wafer, the spherical cap shape comprising an outer region that, in conjunction with the flat rim, is adapted to apply a first force onto a semiconductor wafer against a polishing pad, and an inner region adapted to apply a second force onto the semiconductor wafer against the polishing pad, the first force being greater than the second force [being different from the first force], [whereby] and wherein the first force and the second force cause the polishing pad to planarize the semiconductor wafer substantially uniformly.